R&D dog days
PAGE 44

Battle for X terminals
PAGE 49

Tektronix looks ahead
PAGE 56

A CAHNERS PUBLICATION
SIX DOLLARS

Electronic Business

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES—WORLDWIDE
AUGUST 5, 1991

CAN
TIE
IN?
28

S. Linn Williams
Deputy U.S. Trade
Representative

Electronic Business

VOLUME 17, NUMBER 15 | FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES WORLDWIDE | AUGUST 5, 1991

Cover photo by Patricia Fisher

COVER STORY

28 New chip pact promises wider door to Japan

The trade agreement between the United States and Japan may not have been made in heaven, but both sides have compelling reasons to make it work

The new semiconductor agreement isn't about market share, argues deputy USTR S. Linn Williams, but about creating good business relationships

UPFRONT

Business Trends

9 Failures in electronics are way, way up; HP huddles up on the open-systems playing field; Korea sets its sights on the IC equipment market; the Japanese buy out the Finns, courtesy of the Brits; molecular chip design is on the way; the incredible shrinking disk drive; Intel looks to modules; VHDL picks up steam

Companies to Watch

21 Cumbersome databases make a move to the fast lane; electronic mail hits the air waves; electron beams focus on advanced technology

PAGE 9 Business failures are on the rise for all industries, including electronics

Business Barometer

23 Computers Time warps, computer wars, and forecasts

Commentary

27 Windows one year later

Will Fastie wonders where the Windows market is hiding

FEATURES

International

38 Hard slogging in the Japanese market

Growth slows, earnings suffer at top U.S. and European electronics companies in Japan

Investment

44 Dog days for R&D

Despite healthy sales and profits growth last year, R&D spending by top U.S. electronics companies rose by just 5.3%

Market Perspectives

49 Viewing the terminal market through X windows

X-terminal sales seem set for steady growth. But early entrants into the market feel the heat from computer companies and Asian clones

Strategy

56 A new Tektronix sheds its past

The pioneer in test and measurement equipment now counts on computer graphics and TV equipment to bolster its sagging sales

DEPARTMENTS

Inside Business

5 Chipping away at the trade agreement

Companies in this Issue

59 An index of companies covered in this issue

Advertiser Index

60 An index of the advertisers

My View

63 Looking good

Viewpoint

64 Will the new chip pact work?

EDITORIAL STAFF

Publisher: Frank J. Burge

Editor: Jeffrey Bairstow

Managing Editor: H. Garrett DeYoung, Hugh G. Willett

Senior Editors: Linda Stallmann (Financial), Rick Whiting, Barbara N. Berkman, Teri Sprackland, Elizabeth B. Baatz, Peter L. Burrows

Associate Editors: David Webb

Assistant Editors: Barbara Jorgensen

Copy Editor: Elaine M. Cummings

Contributing Editors: Dwight B. Davis (Seattle), Madeline Franchi (Cahners Economics), Sarah Glazer (Boston), Julie Handelman (Cahners Economics), Nancy Rutter (San Francisco), Paula Doe (Seattle), John Farrell (Cahners Economics), Tom McHale, Joel McCormick, Russ Arensman (Hong Kong), Xiong Xiaoge, John Parker

Correspondents: Charles Cohen (Tokyo), Geoff Crane (Seoul), Chris Brown (Taipei), Ken Stier (Bangkok), Craig Addison (Sydney)

Consulting Editors: Alberto Socolovsky, Allen Furst, Lewis H. Young

Senior Production Editor: Karen J. Covey

Assistant Production Editor: Maura A. Baker

Editorial Assistant: Jean O'Brien

ART STAFF

Art Director: Michael Roach

Associate Art Director: Elizabeth Zisa

Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
275 Washington Street, Newton, MA 02158
(617) 964-3030 Telex: 94 0573 CPC BSN
Fax: (617) 558-4327 MCI: EBBOS

San Jose, Calif.: Hugh G. Willett, Teri Sprackland, David Webb
Sherman Building, 3031 Tisch Way, Suite 100
San Jose, CA 95128 (408) 243-8838
Fax: (408) 243-2144

Northwest: Dwight B. Davis
11020 86th Ave. NE
Kirkland, WA 98034 (206) 820-5741

London: Barbara N. Berkman
27 Paul Street
London EC2A4JU England 011-44-71-628-7030
Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky

Director of Production/Manufacturing: John R. Sanders

Production Supervisor: Andrew A. Jantz

Production Assistant: Julie T. Kohn; (617) 964-3030

CIRCULATION

Circulation Mananer: Ann Ward
44 Cook Street, Denver, CO 80206
(303) 388-4511

Total Circulation: 77,804

REPRINTS

ELECTRONIC BUSINESS articles are available on a custom printing basis at reasonable prices. Contact Andrea Marwitz, Cahners Reprint Service, Cahners Plaza, 1350 E. Touhy Ave., P.O. Box 5080, Des Plaines, IL 60018 (708) 635-8800
Electronic Business can be purchased on 35mm microfilm through University Microfilm Int. Periodical Entry Dept., 300 Zeeb Road, Ann Arbor, MI 48106

Chipping away at the trade agreement

PERSISTENCE pays off. If, like Aesop, we could end every story with a moral, that's how we'd wrap up Valerie Rice's analysis of the new five-year trade agreement between U.S. and Japanese chip makers.

And what persistence. For the past four years, despite a standing agreement between the semiconductor industries of both nations, there had been disagreement, if not outright animosity, on all fronts. The new five-year accord finally meets a number of key U.S. objectives.

Not that the new trade agreement is perfect. While the new agreement (unlike the old one) specifically mentions a 20% share of the Japanese chip market for foreign manufacturers, that figure is just a target, not a guarantee. But putting that target in plain view is surely progress.

The other crucial aspect of the new agreement has to do with market access and increasing design-in and partnering between U.S. and Japanese companies in specific market segments. That's a big step forward from the days when *keiretsu* was a dirty word for anyone trying to land a purchase order in Japan.

Analysts agree that a key difference in this round of semiconductor trade talks was the willingness of the U.S. to take a decisive role. Will the Bush administration have the persistence to enforce the new agreement? That's one critical question. Another is if U.S. semiconductor companies will take advantage of new market opportunities in Japan. There will be far fewer excuses this time around.

Associate art director Elizabeth Zisa

Written analysis of important developments like the chip-trade agreement is a big part of this magazine's job. But the graphical element is also important, and in some cases the graphics *are* the story. Our report on top R&D spenders in this issue is a case in point. Since you won't find a staff byline on our charts, graphs, and illustrations, we'll take this opportunity to introduce our new graphics designer, associate art director Elizabeth Zisa.

Elizabeth is new to ELECTRONIC BUSINESS—this is her third issue—but she has been with Cahners for nearly five years. Working with art director Mike Roach, Elizabeth lays out features and departments and helps assign and collect much of the artwork, often under heavy deadline pressure. The most satisfying part of the job? "When the art and the editorial come together—and it really works."

—By John Parker

ELECTRONIC BUSINESS® (ISSN 0163-6197, GST Reg. #123397457) is published twice a month, except monthly in December, by The Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M. McDermott, President; Frank Sibley, Executive Vice President; Jerry D. Neth, Senior Vice President/Publishing Operations; J.J. Walsh, Senior Vice President/Finance; Thomas J. Dellamaria, Senior Vice President/Production and Manufacturing; Ralph Knupp, Vice President/Human Resources. ELECTRONIC BUSINESS® is a registered trademark of Reed Properties Inc., used under license. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303)388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. **POSTMASTER: Send address corrections to ELECTRONIC BUSINESS®, PO Box 173377, Denver, CO 80217-3377.** ELECTRONIC BUSINESS® copyright 1991 by Reed Publishing USA; Ronald G. Segel, Chairman and Chief Executive Officer; Robert L. Krakoff, President and Chief Operating Officer; William M. Platt, Senior Vice President. Annual subscription rates for non-qualified people: USA, $84.95; Mexico, $124.95; Canada, $133.70; other countries, $149.95 per year; $140, air mail surcharge. Subscriptions include all issues. Except for special issues where price changes are indicated, single copies are available for $15.00 (USA, Canada/Mexico and foreign). Please address all subscription mail to Eric Schmierer, 44 Cook Street, Denver, CO 80206-5800. Cahners Publishing Company, A Division of Reed Publishing USA • Specialized Business Magazines for Building & Construction • Research • Technology • Electronics • Computing • Printing • Publishing • Health Care • Foodservice • Packaging • Environmental Engineering • Manufacturing • Entertainment • Home Furnishings • Interior Design. Specialized Consumer Magazines for Child Care • Boating • Wedding Planning

VBPA ABP

ECONOMICS

Failures in electronics are way, way up

OK. SO THIS HAS BEEN a *mild* recession. Tell that to the 416 computer, electronics, instruments, and research and testing service companies that shut their doors in the first four months of 1991. That's 50% higher than the number of failures during the same period a year ago, and much higher than the 10% rise in electronics failures between 1989 and 1990.

"The electronics industry has been given a strong dose of survival-of-the-fittest medicine lately," says Maddy Franchi, senior economist with Cahners Economics in Newton, Mass. The computer and data processing equipment makers have had the worst time. With 185 companies filing for bankruptcy or Chapter 11, failures rose 75% in the first four months of 1991. At that rate, over 555 computer and related companies could be out of business by year-end, compared with 371 companies the year before.

The explosion of business failures has hit all industries. According to The Dun & Bradstreet Corp., which tracks failures across the United States, all business failures jumped 55% in early 1991 compared with a year ago. Says D&B's Reid H. Gearhart, "Although the '80s showed a long and sustained expansion, much of the Midwest was actually pretty weak due to the rolling recessions, first in petroleum and then agriculture. The recession in the Northeast has now sent failures through the roof, with the jump in failures spilling over lately into the Middle Atlantic states."

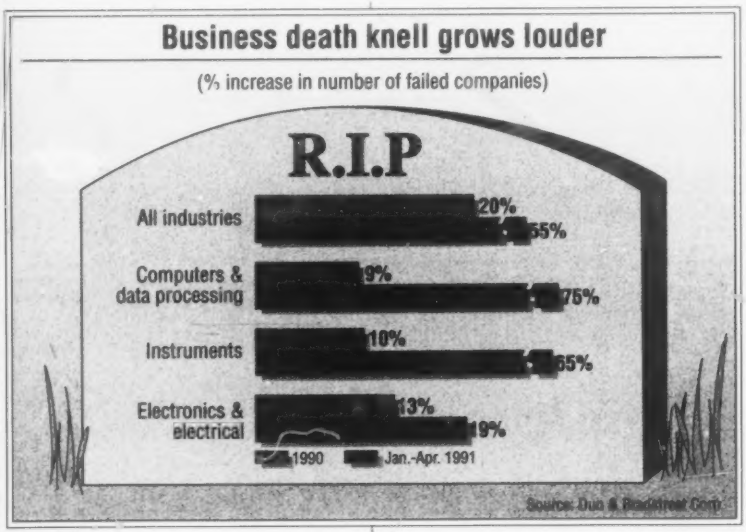
Two traditional high-tech bastions were hit particularly hard, reports D&B. Bankruptcies in the New England states were up 108% to 466 in April 1991 from 224 in April 1990. "The Pacific region—which was one of the star regions during the economics expansion—is continuing to show signs of stress," says Gearhart. "Business failures increased 85.4% in April to 1,485, with California posting a 69.5% increase."

Even as indicators point toward a recovery, don't look for an immediate improvement in the rate of business closures. "Increasing business failures tend to be a lagging economic indicator, so I would anticipate the trend to continue before we see the benefits of the expected economic recovery," says D&B economist Doug Handler. It could be another six months to a year before the pace begins to change. "The economic upturn will not be enough," he warns. "It's a case of too little too late for quite a few companies."

In the electronics industry, he notes, there are some causes for optimism; capital spending is on the upswing, for example. But in spite of the ongoing success in electronics innovation—new-generation computers, chips, and so forth—Handler notes that prices haven't kept up with that pace. "And that doesn't translate into revenue," he adds.

Without a strong economic recovery (which most experts agree is unlikely), those companies on the brink cannot count on relief in the near future. Unlike Chrysler or Wang Laboratories, there is no white knight waiting to help the slew of small electronics companies that are bleeding red ink and are headed for Chapter 11 this year.

—By Elizabeth B. Baatz



COMPUTER SYSTEMS

HP huddles up on the open-systems playing field

IN THE MIDST of alliance-forging and open-systems maneuvering between computer hardware and software vendors, Hewlett-Packard Co. has been quietly working in the background all by itself. And with its June release of the high-power, low-cost HP 3000 and 9000 commercial-market systems, the company is now positioned to compete across the board with the best price/performance offerings from IBM, DEC, AT&T/NCR, and Fujitsu.

"We want to be the No. 2 company next to IBM" in the computer industry, says Bernard Guidon, general manager of HP's General Systems Division. With that kind of ambition, it may behoove the rest of the hud-

book" or handheld PCs, particularly the emerging pen-based systems.

At least one other start-up, MiniStor Peripherals of San Jose, is gearing up with a 1.8-inch design; other suppliers of larger form-factor disk drives (namely Seagate, Conner, and IBM) are thought to have 1.8-inch design efforts underway. MiniStor CEO Alex Malaccorto says that Integral has a 20-Mbyte drive that won't get much interest from the notebook vendors MiniStor intends to target, while MiniStor's first product will be a "more than 50-Mbyte" design geared primarily to notebook computers.

According to analysts at International Data Corp., vendors next year should ship about 50,000 1.8-inch drives. IDC predicts shipments of 350,000 in 1993 and 1.7 million by the end of 1994.

—Dave Webb in San Jose

CHIP MODULES

Intel looks to modules to add value

ONE OF THE fastest-growing segments of the memory chip and microprocessor business, multichip modules allow chip makers to integrate several chips in a single package to save circuit board space or reduce design time. More than half of all 4-Mbit DRAMs—the up-and-coming generation—will be sold in modules, according to Dataquest in San Jose. Modules can also add value to more-sophisticated chips.

Intel, beset by competition from both the RISC microprocessors and clones of its own 80x86 family, is looking to add value through the sale of its microprocessors in multichip modules. Intel claims the module eliminates problems that occur when users design systems around faster processors.

Other microprocessor makers—such as LSI Logic Corp., with its Sparc and MIPS-based RISC processors—have recently offered high-performance multichip modules that integrate cache controllers and memory to save design time and cost. In Santa Clara, nChip Inc. claims to offer faster system performance through modules that can integrate entire chip-based subsystems on a single conductive substrate.

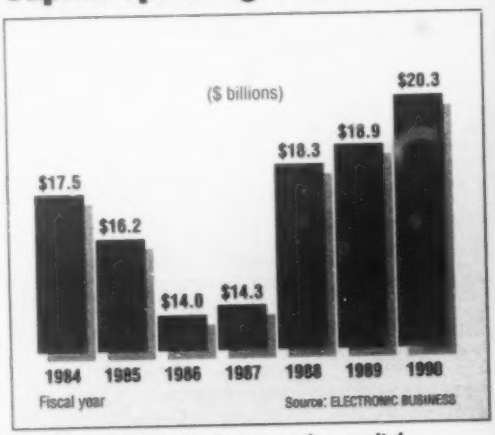
The latest 50-MHz version of Intel's 486 MPU, introduced last month, included a 486 packaged in a multichip module containing the processor, a cache memory controller, and nine fast static RAM (SRAM) memory chips.

At the 50-MHz speed timing becomes very critical, notes Michael Slater, president of MicroDesign Resources. High-frequency processors also generate unwanted electronic noise that must be suppressed through additional design work, he adds.

—Hugh G. Willett in San Jose

CAPITAL INVESTMENT

Capital spending on the rise



After plummeting in the last recession, capital spending by the top 100 capital spenders in the electronics industry has grown four years in a row. At $20.3 billion, 1990 spending by these companies grew 7.4% above aggregate capital spending by the 100 top spenders in 1989. Watch for our exclusive ranking of the top 100 capital spenders in the next issue.

—Elizabeth B. Baatz

DESIGN AUTOMATION

VHDL picks up steam

VHDL, THE Pentagon-backed hardware description language devised to simplify the design and manufacture of electronic components and systems, is suddenly picking up steam. Vendors of CAD tools and ASICs have created a group called VHDL International to promote use of the language, design tools are filling critical gaps in the marketplace, and early adapters are settling into VHDL-based design methodologies that offer improved productivity and time to market.

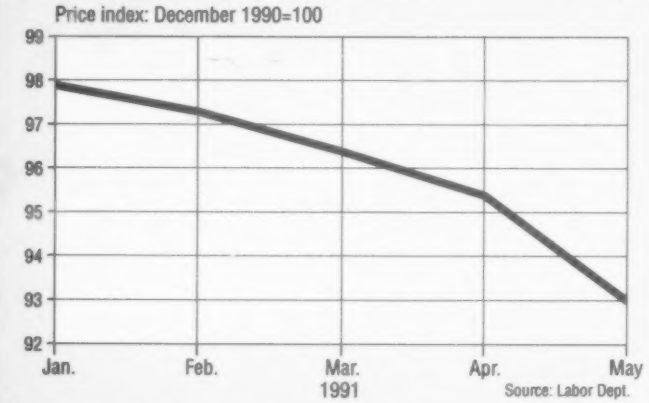
Silicon Graphics, for example, more than tripled its engineering productivity on the design of 14 chips using VHDL-based design and Arche Technologies recently cut development time in half in developing three CMOS ASICs.

VHDL lets engineers design chips and systems by describing what they do rather than by drawing the gates and transmission lines of which they are composed. When used in conjunction with translation synthesis tools, the language frees engineers to think about what to design rather than how to design it.

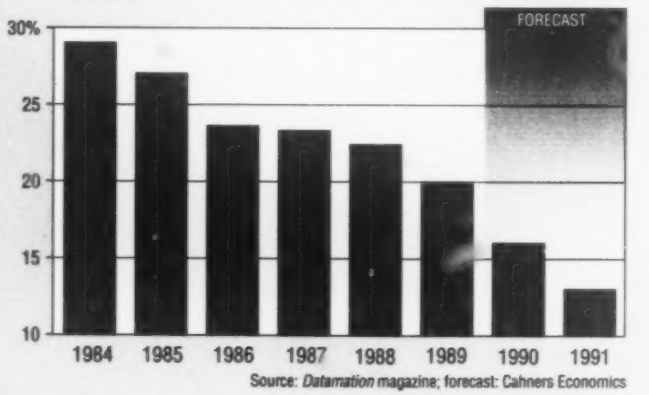
Market watchers agree that VHDL is about to get hot. Of 625 designers polled by *EDN* magazine earlier this year, 22% plan to buy VHDL tools in the next year; that earned VHDL fourth place in the magazine's "plan-to-purchase" ranking for 1991. And Dataquest expects VHDL to take 63% of the HDL market by 1994, overtaking a language from Cadence Design Systems, which now holds a 56% share.

—Peter Burrows

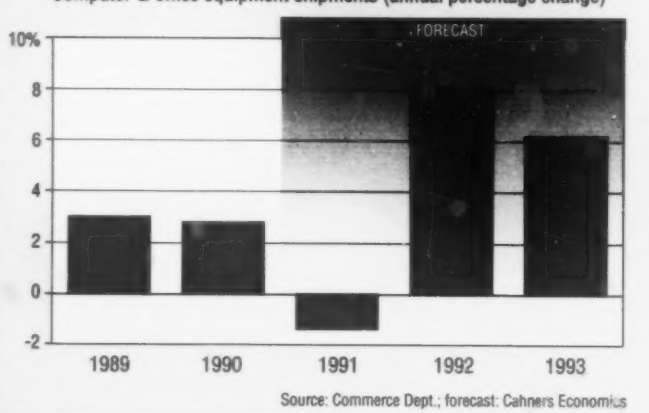
Price wars tear apart the computer industry...



...and "big iron" revenues retreat worldwide...



...leaving U.S. industry shipments vulnerable



Time warps, computer wars, and forecasts

LONG AGO, U.S. computer manufacturers enjoyed astronomical growth rates and high profit margins. But unless they can pass through a time warp, computer makers will be living with slower growth and lower margins for some time to come.

According to the U.S. Department of Labor, prices of all computers slid 5% from January to May 1991. The price decline in the desktop market has been even more severe. The shift to lower-margin products began years ago. According to *Datamation* magazine, ELECTRONIC BUSINESS's sister publication, revenues from mainframes and minicomputers accounted for 29% of total information systems revenues in 1984 for the 100 largest worldwide information systems companies. Cahners Economics estimates that share will fall to 13% this year. In response, the onetime "big iron" companies have been shedding people and restructuring in order to lighten their cost loads.

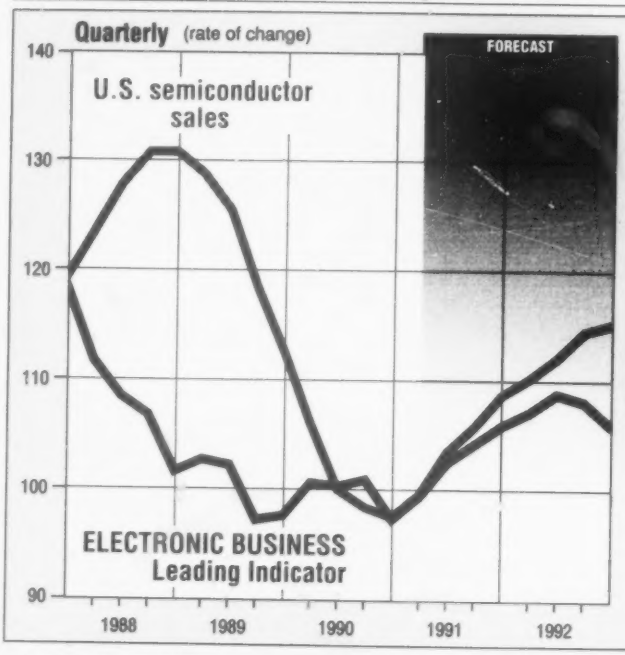
Price erosion, teamed with the general recession, battered away at computer and office equipment shipments this year. Dollar-denominated shipments fell below year-ago levels each month from December 1990 through April 1991.

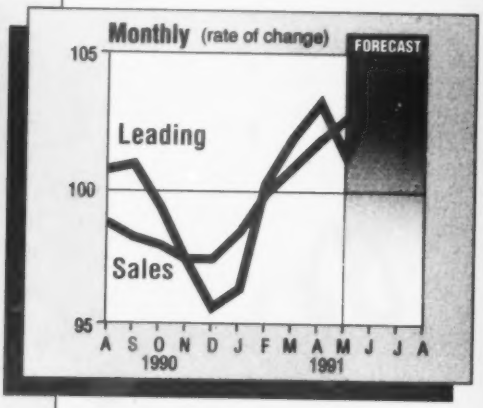
Consequently, Cahners Economics' original shipments forecast, made in December 1990, of 4.4% growth for 1991 has fallen by the wayside. The economic expansion began in June 1991, but shipments growth for computers and office equipment may not fully recover until later this year, leaving annual shipments down 1.4% from 1990.

With the start of the expansionary phase, tenuous as it may be, the price war will evolve into an uneasy truce. Once the battlefield clears, the survivors can enjoy the new world order.

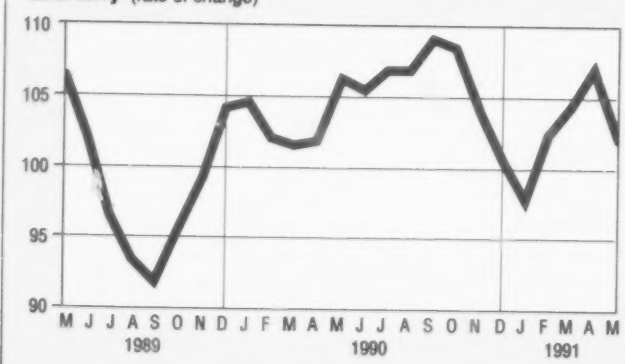
—Madeline Franchi

ELECTRONIC BUSINESS Leading Indicator





Backlash in semiconductor orders drags EBLI



Source: Semiconductor Industry Association

Chip bookings trip up Leading Indicator

THE BRAKES were applied to the ELECTRONIC BUSINESS Leading Indicator (EBLI) in May. After a steady recovery from a low of 95.6 in December 1990 to 103.2 in April, the leading indicator stumbled back to 101.3. Warning: The turnaround in the electronics industry will most likely be a bumpy one and produce a relatively mild expansion. EBLI will peak again in June 1992.

EBLI is a weighted composite of six statistics that tend to lead activity in the electronics industry. To obtain your complimentary background paper, contact Cahners Economics, 275 Washington St., Newton, MA 02158-1630; telephone (617) 630-2119; fax (617) 630-2100

	Latest month	Previous month	Year ago	1989 average
ELECTRONIC BUSINESS Leading Indicator (rate of change, May)	101.3	103.2	100.9	99.9
U.S. semiconductor bookings ($ millions, 3-month average, May)	$1,348	$1,448	$1,400	$1,254
Weekly hours of semiconductor production workers (monthly average, Apr.)	40.7	41.1	41.0	40.4
Electronic components lead time index (1977 = 100, Jun.)	94.2	93.3	82.4	80.7
S&P's semiconductor stock price index (1970 =10, monthly average, May)	73.2	74.8	74.6	64.6
Change in electronic components inventories ($ millions, SA, Apr.)	$85	$19	$46	$33
Contracts and orders for plant and equipment ($ billions, SA, Apr.)	$33.4	$35.0	$37.3	$38.2

SA = seasonally adjusted; all other data are not seasonally adjusted

Sources: Semiconductor Industry Association, Bureau of Labor Statistics, *Electronics Purchasing*, Standard & Poor's, Commerce Dept., Bureau of Economic Analysis

Hard slogging in the Japanese market

Growth slows, earnings suffer at top U.S. and European electronics companies in Japan

By Paula Doe

ELECTRONIC BUSINESS tracks sales of U.S. and European electronics companies in Japan from company reports, government filings, and discussions with company officials and market researchers. This net should catch companies with significant corporate entities in Japan but does not include companies that sell through agents in Japan.

We include companies with minority non-Japanese ownership if the company is big enough for the minority percentage of sales to be on our list; if no one else owns a larger stake; if it sells largely U.S. or European technology; and if it has non-Japanese managers.

What do major U.S. and European electronics companies in Japan have to show for yet another year of trade talks and market opening efforts in the Japanese market? Mostly slower growth and lower profits.

Despite years of effort, growth for most U.S. and European companies in Japan isn't picking up—in fact, it's slowing down. The 20 largest U.S.-owned electronics companies in Japan increased their total yen-based sales in the Japanese market by 9% in fiscal 1990—to the equivalent of $20.2 billion—down from 12% growth in 1989 and 24% growth in 1988, when U.S. companies got a one-time boost from the devaluation of the dollar.

Making a profit in Japan isn't getting any easier either. Most U.S. companies that report earnings in Japan saw profits stagnate or decline, as a slightly higher dollar in-

James Steinberg

creased the cost of imports to Japan. Big computer makers IBM Japan, Nihon Unisys, and DEC Japan saw earnings plummet between 19% and 60% as the Japanese financial institutions on which they depend cut purchases.

Granted, 1990 was also a tough year for Japanese companies. The Electronic Industry Association of Japan (EIAJ) estimates total electronics production by Japanese companies climbed only 5% for the year, although that figure largely reflects recession in other countries, which trimmed demand for exports from Japan.

More significant for U.S. electronics companies, Japan's booming real estate and financial markets slowed down, so banks and securities companies cut spending.

Still, Japanese GNP kept up the same steady 5% growth in 1990 as in 1989, and most analysts figure the country's computer market saw around 10% growth. Major Japanese

Top U.S. and European electronics companies in Japan

	Sales in Japan ($ millions)	% change (in yen)	Total sales* ($ millions)	Net income ($ millions)	% change (in yen)	Fiscal year	Ownership
1 **IBM Japan**	$6,735	2	$9,212	$575	-19	12/90	IBM 100%
2 **Fuji Xerox**	3,744	10	3,744	161	4	10/90	Rank Xerox 50%, Fuji Photo Film 50%
3 **Nihon Unisys**	2,369	13	2,369	14	-57	3/91	Unisys 33.3%, Mitsui 33.3%
4 **Yokogawa HP**	1,047	17	1,117	67	-3	10/90	HP 75%, Yokogawa Electric 25%
5 **Yamatake Honeywell**	1,020	10[1]	1,211	37	-34	9/90	Honeywell 24.1%
6 **DEC Japan**	720	9	894	30	-54	6/90	DEC 100%
7 **NCR Japan**	717	2	830	69	0	11/90	NCR 100%
8 **Motorola**	650	29[2]	NA	NA	NA	12/90	NA
9 **TI Japan**	614	5	1,035	-69	NM	12/90	Texas Instruments 100%
10 **AMP Japan**	465	10	NA	NA	NA	11/90	AMP 100%
11 **Nihon Sun**	370	60	NA	NA	NA	6/90	Sun 100%
12 **Intel Japan**	367	27	NA	NA	NA	12/90	Intel 100%
13 **Yokogawa Medical**	260	20[1]	433	NA	NA	11/90	GE 75%, Yokogawa Electric 25%
14 **Olivetti Japan**	245	9	245	0.5	-62	12/90	Olivetti 80%, Toshiba 20%
15 **Philips**	230[3]	38[1]	362[4]	7[4]	234[4]	12/90	Philips 51%
16 **Applied Materials Japan**	196	5	196	NA	NA	10/90	Applied Materials 100%
17 **Sony Tektronix**	185	-8	192	NA	NA	5/90	Tektronix 50%, Sony 50%
18 **Memorex Telex**	179	10	267	2	-62	3/91	Memorex Telex 52.2%, Kanematsu 24.5%
19 **National Semiconductor**	143	3	NA	NA	NA	12/90	NA
19 **Tandem Computer**	143	31	143	NA	NA	9/90	Tandem 100%
21 **Apple Japan**	140	NA	NA	NA	NA	9/90	Apple 100%
21 **Molex Japan**	140	5[1]	203	26	-8	6/90	Molex 100%
23 **AMD**	139	1	180	NA	NA	12/90	AMD 100%
24 **Nemic Lambda**	105	NA	105	9	NA	5/90	Veeco 64%, Rikizo Madarame 24.9%
25 **Nippon Data General**[5]	102	-12	102	NA	NA	9/90	Data General 85%

All yen converted at the 1990 average rate of Y144/$1. Companies with different fiscal years used slightly different exchange rates in their own reporting

[1]Growth of total sales of Japanese unit

[2]Growth of semiconductor sales only

[3]Sales of Marantz Japan (audio, video, telecommunications equipment, and semiconductors) only. Does not include other Philips imports

[4]Figures for Marantz Japan

[5]Aquired by Omron Mar. 1991

*Sales in Japan plus exports to U.S. and other countries

NA = not available

NM = not meaningful

Source: ELECTRONIC BUSINESS; semiconductor sales figures supplied by Dataquest Inc.

The top 12 electronics companies in Japan

Sales in Japan ($ billions)

Hitachi	$34.3	IBM Japan (U.S.)	6.7
Matsushita	20.4	Sony	5.5
Toshiba	18.4	Sanyo	5.2
NEC	16.2	Sharp	4.3
Mitsubishi Electric	14.6	Fuji Xerox (U.S.)	3.7
Fujitsu	12.3	Ricoh	3.4

Source: ELECTRONIC BUSINESS

computer makers managed double-digit growth at home. Fujitsu Ltd.'s computer sales in Japan climbed 17% to about $10.1 billion in 1990. Toshiba Corp.'s sales were up 16% to $3.04 billion, NEC Corp. saw sales rise 13% to $9.1 billion, and Hitachi Ltd.'s sales increased 11% to $6.75 billion.

In contrast, IBM Japan's sales increased a mere 2% to $6.74 billion, relegating the U.S. giant to fourth place in the Japanese computer market, behind Fujitsu, NEC, and Hitachi. NCR Japan, at 2% growth, and DEC Japan, at 9%, also lagged their Japanese competitors. Their $700 million or so in sales was dwarfed by all the Japanese computer makers.

Some U.S. companies did very well. Motorola Inc. and Intel Corp. increased their sales of semiconductors in Japan by 29% and 27% respectively, to $438 million and $367 million, outpacing the growth of the big Japanese suppliers. EIAJ estimates that total Japanese semiconductor output declined 1% in 1990.

Some computer makers made big gains too. Sun Microsystems Inc. saw 60% growth, reaching sales of roughly $370 million in Japan. Tandem Computers Inc. increased its sales by 31%, to $143 million, making our list of leading companies for the first time.

Respectable showings were also made by some larger companies, whose bigger bases make double-digit gains amount to some real money. Yokogawa-Hewlett-Packard achieved 17% growth in the Japanese market, reaching sales of $1 billion; the acquisition of Apollo Computer Inc.'s Japanese subsidiary accounted for part of the increase. Nihon Unisys increased its sales 13%, to $2.37 billion, matching the major Japanese computer makers' growth rates, although earnings suffered.

At the risk of repeating a too familiar story, it is worth noting that $20 billion sales of major U.S. electronics companies in Japan is small potatoes compared with total Japanese electronics production that the EIAJ puts at some $184 billion.

This year we added European-owned companies in Japan to our annual listing but found only three players with sales above the $100 million mark. Sales of all top 25 U.S. and European electronics companies in Japan reached $21 billion. Any one of the leading Japanese electronics companies sells almost that much in Japan on its own. Hitachi's sales in Japan reached $34 billion in 1990, Matsushita Electric Industrial's sales were $20 billion, NEC's were $16 billion, Mitsubishi Electric had $14 billion in sales, and Fujitsu had $12 billion.

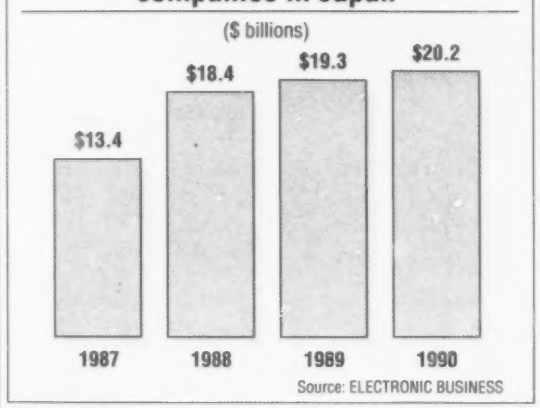
Of course there are many smaller U.S. electronics companies in Japan that aren't included on our list, but even 20 more companies with sales of $50 million each would add only another $1 billion to the total.

MOST SUCCESSFUL among the European companies in Japan are N.V. Philips and Ing. C. Olivetti. Olivetti's 80%-20% joint venture with Toshiba reports about $245 million in sales of Olivetti and Toshiba computers and office automation equipment in Japan.

Philips's Japanese manufacturing unit, Marantz Japan, increased its total sales by 38% in 1990, to $362 million, selling about $154 million of that audio, video, and telecommunications equipment in Japan. Philips also sold about $72 million worth of semiconductors in Japan, according to estimates of Dataquest Inc. of San Jose. Philips Japan also claims $500 million in sales from Japanese customers for electronic components delivered to Japanese plants in Europe and the Americas.

Other big European names in electronics aren't doing big volume in Japan. Siemens's Japanese subsidiary reports that its sales in Japan are about $50 million, while Thomson S.A. increased its semiconductor sales 82% to $40 million. □

Sales by top 20 U.S. electronics companies in Japan



Source: ELECTRONIC BUSINESS

TOP 100 R&D SPENDERS

Dog days for R&D

Despite healthy sales and profits growth last year, R&D spending by top U.S. electronics companies rose by just 5.3%

By Charles Procter

It was a year for caution. Sales by the top 100 U.S. electronics R&D spenders in 1990 grew by 9.0%, and profits posted a whopping 20.7% increase. But research and development spending rose by a meager 5.3%. This growth rate marks a three-year low, having peaked at 22.9% in 1987.

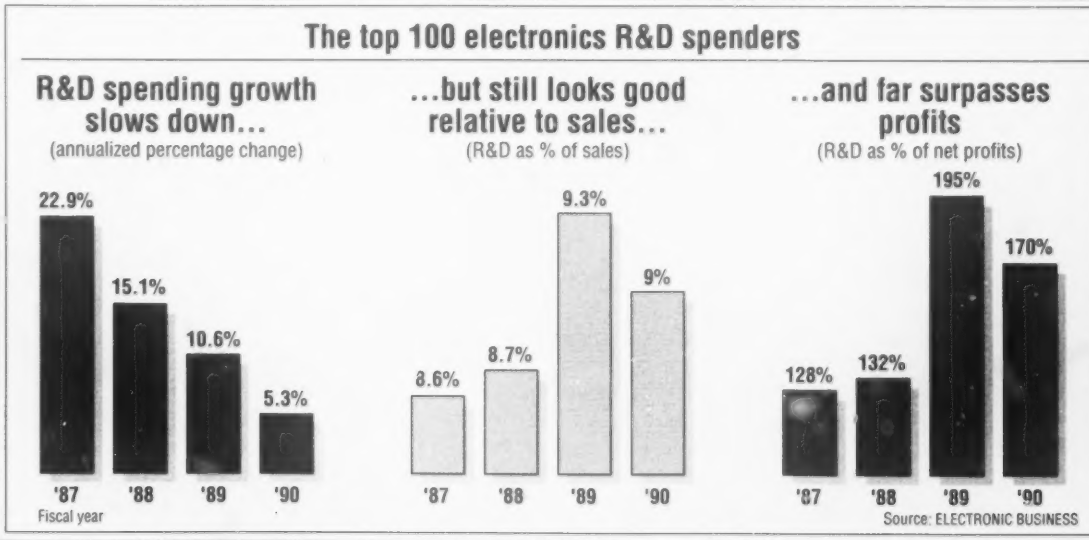
These 100 companies accounted for about 29% of all company-funded R&D spending in the United States last year. But the mediocre showing among the best and brightest in the industry is probably not a sign of serious trouble. Instead it simply reflects the strong relationship between sales, profits, market expectations, and R&D spending, says John Gawalt, a science resource analyst at the National Science Foundation in Washington, D.C.

Total R&D spending for these companies rose to $21.2 billion last year, up from $20.1 billion in 1989. As a percentage of sales, R&D dropped to 9.0% in 1990 from a high of 9.3% in 1989. This dip may be explained in part by the fact that over half of the companies on the list posted losses or declines in profits. "It's hard to spend it when you don't have it," offers one executive. And considering the effects of the recession and the expectations for slow market growth ahead, many companies capped R&D spending growth in 1990 and may do so again in 1991 unless demand rebounds.

There are exceptions, of course. One is Cypress Semiconductor Corp., the San Jose maker of SRAMs. Cypress topped this year's list by spending 24.7% of sales on R&D in 1990, up slightly from 23.9% in 1989. CEO T. J. Rodgers developed a financial model that calls for maintaining R&D at between 24% and 25% of sales a year, says Antonio Alvarez, Cypress's vice president of R&D. About a quarter of that money goes to process-related R&D and the rest to product development. Heavy R&D spending has been a key to the company's success, say observers, and Cypress has maintained consistent sales and profit growth over the last few years as it diversifies into new markets.

Other high fliers are following in

The top 100 electronics R&D spenders



Measuring the top U.S. R&D spenders

R&D expenditures ($ millions)		R&D spending growth (percentage change from 1989)		R&D spending per employee	
IBM	$6,554.0	Seagate Technology	103.6%	Chips and Technologies	$68,456
Digital Equipment	1,614.4	Archive	79.9	Cypress Semiconductor	34,829
Hewlett-Packard	1,367.0	Encore Computer	71.9	Amdahl	34,643
Motorola	1,008.0	Oracle Systems	67.9	Quantum	33,776
Xerox	848.0	Silicon Valley Group	66.6	Apple Computer	32,903
Unisys	746.5	Micron Technology	66.5	Microsoft	32,052
GM Hughes Electronics	568.0	Microsoft	63.9	Applied Materials	29,584
Texas Instruments	540.0	Sequent Computer	62.6	Lotus Development	29,329
Intel	516.7	Conner Peripherals	58.5	Mentor Graphics	27,138
NCR	502.0	Teradata	53.8	Cray Research	26,440

Fiscal year 1990 Source: ELECTRONIC BUSINESS

Cypress's footsteps. Fourth-ranked Cadence Design Systems, a first-time entrant on our R&D ranking, translates strong R&D spending into solid sales and profit growth. With an R&D spending rate of 18.4%, Cadence posted sales growth of 44.8% and a 45% jump in profits last year.

Like Cypress and Cadence, strong R&D spending is the cornerstone of Chips and Technologies Inc.'s success. Ranked #11 this year in terms of R&D spending as a percentage of sales, Chips and Technologies tops the list for R&D spending per employee, shelling out $68,456 for each of its 665 employees. As a fabless semiconductor company driven by a need for ever-faster product development, the company is entirely dependent on R&D spending to stay ahead of the competition in the chipset business. Over 70% of its employees are classified as R&D personnel, and it spends twice as much per employee as Cypress and almost six times more than the average company on the list. The company points to its 1990 sales growth of 34.8% as proof that its R&D spending strategy works.

Still, companies like Chips and Technologies, Cypress, and Cadence are small fry when compared with IBM, which again this year topped the list for total R&D dollars. Big Blue's 1990 R&D budget totaled $6.6 billion, accounting for nearly one-third of all spending by the top 100 electronics companies. A wary IBM cut R&D spending by 4% in 1990, or $273 million, from a $6.8 billion level in 1989. Even so, it outspent even General Motors last year, to top the list for U.S. corporate R&D spenders. Other big electronics spenders include Digital Equipment Corp. (#29), Hewlett-Packard Co. (#43), Motorola Inc. (#52), and Xerox Corp. (#75). Together with IBM, these companies spent $11.4 billion on R&D in 1990, or half the total of the top 100. All five reported positive sales growth, and all but DEC and HP posted profit increases.

Nineteen companies out of the 100 curtailed R&D spending in 1990, down from 21 the previous year. Most notable this year was Control Data Corp., #69 on the list. CDC shrank its corporate R&D budget by 49.1% due to the sale or discontinuation of various operations (particularly Imprimis Technology, its disk-drive operation, which was sold to Seagate Technology Inc.). Ashton-Tate, the top R&D spender in 1989, saw its R&D spending shrink by 42.2% because of cost-reduction programs and completion of certain software development projects.

At the other end of the spectrum were the companies that experienced meteoric increases in R&D spending. Leading this list was Seagate Technology (#93), posting a 103.6% increase in R&D spending for the year (the result of the Imprimis Technology acquisition from CDC). Similarly significant increases were recorded by Archive (#66), Encore Computer (#16), and Oracle Systems (#54).

BY MOST ACCOUNTS, R&D budgeting in 1991 will reflect the continued uncertainty that pervaded budgeting plans in 1990. Even as the U.S. economy emerges from the recession, don't expect a sharp increase in R&D spending this year. In fact, the industry may continue to view R&D as an area to extract savings.

This may not be such a bad thing. There is a lot of talk in corner offices about the need for improving the product development process rather than continuing to throw money into the R&D pit. Companies are finding ways to work smarter instead of harder at invention, design, and process improvement. As a result of this change in philosophy, traditional R&D measures may no longer accurately reflect U.S. electronics companies' investment in the future.

continued

To qualify for the ELECTRONIC BUSINESS R&D ranking, companies must be U.S.-based, publicly traded, derive at least 50% of their revenue from electronics-related sales, and be included in the ELECTRONIC BUSINESS 200 listing.

R&D rank 1990	1989	Company/Location	R&D as % sales	R&D expenditures ($ millions)	% change from 1989	Fiscal 1990 sales ($ millions)	% change from 1989	Fiscal 1990 profits ($ millions)	% change from 1989	Fiscal year
1	2	**Cypress Semiconductor** San Jose	24.7%	$55.6	16.7%	$225.2	13.0%	$33.2	8.2%	12/90
2	5	**Integrated Device Technology** Santa Clara	19.9	41.6	35.1	209.5	15.9	17.0	-5.2	3/90
3	4	**Advanced Micro Devices** Sunnyvale, Calif.	19.2	203.7	0.9	1,059.2	-4.1	-53.6	NM	12/90
4	—	**Cadence Design Systems** San Jose	18.4	42.6	37.0	231.4	44.8	38.0	45.0	12/90
5	1	**Ashton-Tate** Torrance, Calif.	17.2	39.7	-42.2	230.5	-13.1	-18.1	NM	12/90
6	17	**Mentor Graphics** Wilsonville, Ore.	17.1	74.5	46.3	435.2	14.5	23.6	-47.3	12/90
7	13	**Applied Materials** Santa Clara	17.1	97.1	34.3	567.1	13.0	34.1	-33.8	10/90
8	10	**Analog Devices** Norwood, Mass.	16.6	80.3	16.5	485.2	7.0	-12.9	NM	10/90
9	7	**VLSI Technology** San Jose	16.5	53.6	14.8	324.8	12.6	-12.7	NM	12/90
10	3	**Cray Research** Eagan, Minn.	16.0	128.4	-10.4	804.4	2.5	113.0	26.9	12/90
11	9	**Chips and Technologies** San Jose	15.5	45.5	35.7	293.4	34.8	29.3	-11.3	6/90
12	16	**Microsoft** Redmond, Wash.	15.3	180.6	63.9	1,183.4	47.3	279.2	63.7	6/90
13	8	**National Semiconductor** Santa Clara	15.1	252.4	-4.7	1,675.0	1.6	-29.3	NM	5/90
14	6	**Lotus Development** Cambridge, Mass.	15.0	102.7	8.8	684.5	23.1	23.3	-65.8	12/90
15	23	**Tellabs** Lisle, Ill.	15.0	31.6	33.4	211.0	16.4	8.1	14.9	12/90
16	—	**Encore Computer** Fort Lauderdale, Fla.	14.8	31.8	71.9	215.2	36.3	-30.1	NM	12/90
17	19	**Teradyne** Boston	14.6	66.9	4.6	458.9	-5.1	-21.3	NM	12/90
18	22	**Amdahl** Sunnyvale, Calif.	14.4	310.1	11.8	2,158.8	2.7	184.0	20.3	12/90
19	20	**Stratus Computer** Marlborough, Mass.	14.2	57.4	27.2	403.9	18.3	37.0	4.5	12/90
20	21	**Tektronix** Beaverton, Ore.	13.8	194.6	2.9	1,408.3	-1.7	-92.6	NM	5/90
21	—	**Silicon Valley Group** San Jose	13.7	25.3	66.6	184.3	40.6	4.4	-53.7	9/90
22	26	**Tandem Computers** Cupertino, Calif.	13.6	253.6	24.6	1,865.9	14.3	121.8	3.0	9/90
23	25	**Computer Associates** Garden City, N.Y.	13.2	171.2	28.3	1,296.0	25.8	157.8	-3.5	3/90
24	29	**Intel** Santa Clara	13.2	516.7	41.5	3,921.3	25.4	650.3	66.3	12/90
25	15	**Teradata** El Segundo, Calif.	13.0	29.1	53.8	224.2	63.2	18.8	89.4	6/90
26	—	**Convex Computer** Richardson, Tex.	13.0	27.2	31.4	209.3	32.0	18.4	61.0	12/90
27	31	**Concurrent Computer** Tinton Falls, N.J.	12.7	43.0	33.5	340.1	22.3	-41.7	NM	6/90
28	—	**Borland International** Scotts Valley, Calif.	12.6	14.3	-0.1	113.3	25.1	11.8	NM	3/90
29	27	**Digital Equipment** Maynard, Mass.	12.5	1,614.4	5.9	12,942.5	1.6	74.4	-93.1	6/90
30	18	**Sun Microsystems** Mountain View, Calif.	12.2	301.9	28.9	2,466.2	39.7	111.2	82.7	6/90
31	54	**Bolt Beranek and Newman** Cambridge, Mass.	12.1	31.6	28.2	261.9	-10.2	-34.8	NM	6/90
32	39	**Novell** Provo, Utah	11.9	59.3	38.6	497.5	17.9	94.3	94.3	10/90
33	41	**Westmark International** Seattle	11.8	57.0	32.2	484.9	10.5	16.4	-13.8	12/90
34	24	**Data General** Westboro, Mass.	11.6	140.7	-17.9	1,216.4	-7.5	-139.8	NM	9/90
35	37	**Coherent** Palo Alto, Calif.	11.5	21.9	3.2	191.2	-5.2	-0.4	NM	9/90
36	—	**Pyramid Technology** Mountain View, Calif.	11.3	20.3	39.0	179.7	73.0	16.8	101.3	9/90
37	28	**Silicon Graphics** Mountain View, Calif.	10.9	45.6	45.5	419.8	59.1	32.3	180.8	6/90
38	90	**Micron Technology** Boise, Idaho	10.7	35.6	66.5	333.3	-25.3	4.9	-95.4	8/90
39	35	**Intergraph** Huntsville, Ala.	10.5	110.1	20.3	1,044.6	21.5	62.6	-21.3	12/90
40	40	**3Com** Santa Clara	10.4	43.7	13.8	419.1	8.6	20.5	-40.3	5/90
41	33	**General DataComm** Middlebury, Conn.	10.4	21.0	-3.1	201.5	0.2	0.4	NM	9/90
42	—	**Sequent Computer Systems** Beaverton, Ore.	10.4	25.8	62.6	248.8	70.9	18.8	36.9	12/90
43	34	**Hewlett-Packard** Palo Alto, Calif.	10.3	1,367.0	7.7	13,233.0	11.2	739.0	-10.9	10/90
44	—	**Autodesk** Sausalito, Calif.	10.3	24.4	14.4	237.9	33.2	56.8	22.4	1/91
45	38	**DSC Communications** Plano, Tex.	10.0	51.8	17.9	519.3	20.8	20.3	-40.5	12/90
46	47	**Beckman Instruments** Fullerton, Calif.	9.9	80.6	14.7	815.2	3.7	36.2	-13.6	12/90
47	42	**Dynatech** Burlington, Mass.	9.8	42.5	8.5	433.3	8.5	14.7	-20.7	3/90
48	49	**ADC Telecommunications** Minneapolis	9.8	25.5	46.7	259.8	32.3	22.9	39.6	10/90
49	32	**IBM** Armonk, N.Y.	9.5	6,554.0	-4.0	69,018.0	10.1	6,020.0	60.2	12/90
50	—	**Acuson** Mountain View, Calif.	9.5	26.8	32.7	282.8	24.4	47.8	25.7	12/90

NM = not meaningful

R&D rank 1990	1989	Company/ Location	R&D as % sales	R&D expenditures ($ millions)	% change from 1989	Fiscal 1990 sales ($ millions)	% change from 1989	Fiscal 1990 profits ($ millions)	% change from 1989	Fiscal year
51	48	**Medtronic** Minneapolis	9.5%	$79.4	20.3%	$836.6	12.8%	$108.7	11.6%	4/90
52	57	**Motorola** Schaumburg, Ill.	9.3	1,008.0	28.6	10,885.0	13.1	499.0	0.2	12/90
53	43	**LSI Logic** Milpitas, Calif.	9.2	60.2	14.8	655.5	19.9	-34.0	NM	12/90
54	45	**Oracle Systems** Redwood Shores, Calif.	9.1	88.3	67.9	970.8	66.3	117.4	43.6	5/90
55	53	**Wang Laboratories** Lowell, Mass.	8.9	221.9	-8.8	2,497.2	-13.0	-628.6	NM	6/90
56	44	**AMP** Harrisburg, Pa.	8.6	263.0	4.0	3,043.6	8.8	287.1	2.2	12/90
57	50	**Storage Technology** Louisville, Colo.	8.6	98.4	14.8	1,140.6	16.1	70.6	93.7	12/90
58	60	**Apple Computer** Cupertino, Calif.	8.6	478.0	13.8	5,558.4	5.2	474.9	4.6	9/90
59	55	**Fluke** Everett, Wash.	8.5	19.9	-3.5	233.8	-5.6	12.2	-47.4	9/90
60	58	**Applied Magnetics** Goleta, Calif.	8.5	31.2	22.9	368.3	17.3	-10.0	NM	9/90
61	62	**Texas Instruments** Dallas	8.2	540.0	6.7	6,567.0	0.7	-39.0	NM	12/90
62	67	**NCR** Dayton	8.0	502.0	12.6	6,285.0	5.5	369.0	-10.4	12/90
63	70	**Ask Computer Systems** Mountain View, Calif.	8.0	16.5	23.3	207.5	11.4	5.0	-63.1	6/90
64	80	**Watkins-Johnson** Palo Alto, Calif.	7.9	24.5	32.5	311.9	0.4	13.0	-30.4	12/90
65	51	**Western Digital** Irvine, Calif.	7.7	82.1	-4.9	1,070.5	7.9	24.2	-29.6	6/90
66	73	**Archive** Costa Mesa, Calif.	7.6	22.3	79.9	293.2	61.6	11.5	-24.7	9/90
67	65	**Measurex** Cupertino, Calif.	7.6	20.2	-6.7	266.2	-6.7	22.5	-44.6	11/90
68	61	**Perkin-Elmer** Norwalk, Conn.	7.6	63.4	3.0	837.7	6.8	44.2	-5.7	7/90
69	52	**Control Data** Minneapolis	7.5	127.1	-49.1	1,691.0	-42.4	2.7	NM	12/90
70	63	**Unisys** Blue Bell, Pa.	7.4	746.5	-4.5	10,111.3	0.1	-436.7	NM	12/90
71	75	**Maxtor** San Jose	7.2	35.6	51.1	491.1	39.9	18.9	263.4	3/90
72	74	**Gerber Scientific** South Windsor, Conn.	6.7	20.7	2.6	307.2	2.6	32.4	-1.3	4/90
73	84	**Scientific-Atlanta** Atlanta	6.5	39.7	28.9	614.3	12.4	44.3	22.1	6/90
74	88	**Everex Systems** Fremont, Calif.	6.4	27.7	42.7	436.5	15.7	24.5	15.1	7/90
75	76	**Xerox** Stamford, Conn.	6.2	848.0	4.8	13,583.0	9.3	599.0	22.7	12/90
76	56	**Diasonics** Milpitas, Calif.	6.2	16.5	2.8	267.1	37.5	16.4	NM	12/90
77	83	**Andrew** Orland Park, Ill.	6.2	22.6	32.6	366.0	21.2	18.2	11.9	9/90
78	78	**Varian Associates** Palo Alto, Calif.	6.1	77.4	-6.8	1,264.8	-5.9	12.6	-60.0	9/90
79	69	**BancTec** Dallas	6.1	11.3	26.0	185.8	50.4	10.5	36.6	3/90
80	59	**Quantum** Milpitas, Calif.	5.8	25.8	53.4	446.3	114.5	47.2	266.4	3/90
81	81	**Atari** Sunnyvale, Calif.	5.6	22.9	-7.1	411.5	-2.9	-20.8	NM	12/90
82	86	**Molex** Lisle, Ill.	5.5	32.7	9.6	594.4	3.9	62.1	7.6	6/90
83	82	**Loral** New York	5.5	70.0	4.3	1,274.3	7.4	77.5	28.5	3/90
84	64	**Micropolis** Chatsworth, Calif.	5.3	20.3	-13.2	380.6	23.8	7.9	NM	12/90
85	93	**Compaq Computer** Houston	5.2	185.7	40.2	3,598.8	25.1	454.9	36.5	12/90
86	87	**GM Hughes Electronics** Detroit	4.8	568.0	-4.1	11,843.1	3.2	577.2	-8.7	12/90
87	91	**Harris** Melbourne, Fla.	4.8	145.2	39.6	3,027.7	37.9	130.7	12.5	6/90
88	85	**Conner Peripherals** San Jose	4.7	62.9	58.5	1,337.6	89.8	130.1	213.8	12/90
89	—	**Augat** Mansfield, Mass.	4.5	13.6	24.8	299.2	-2.4	17.1	15.0	12/90
90	92	**Honeywell** Minneapolis	4.4	279.6	-1.4	6,309.1	4.1	371.8	-32.4	12/90
91	94	**Kollmorgen** Simsbury, Conn.	4.4	10.5	0.5	238.5	4.7	3.9	NM	12/90
92	79	**Esterline** Bellevue, Wash.	4.4	17.0	-2.0	389.1	36.9	7.1	-10.3	10/90
93	97	**Seagate Technology** Scotts Valley, Calif.	4.3	104.1	103.6	2,413.2	75.9	117.2	NM	6/90
94	—	**Recognition Equipment** Irving, Tex.	4.3	9.9	52.6	230.6	-9.9	-31.7	NM	10/90
95	—	**Diebold** Canton, Ohio	4.3	20.3	51.0	476.1	1.5	27.1	-25.2	12/90
96	89	**Dell Computer** Austin, Tex.	4.1	22.4	33.0	546.2	61.3	27.2	432.5	1/91
97	—	**Zenith Electronics** Glenview, Ill.	4.0	55.9	8.8	1,409.9	-9.0	-52.3	NM	12/90
98	—	**Symbol Technologies** Bohemia, N.Y.	3.8	8.7	13.2	231.5	4.1	7.6	-60.1	12/90
99	—	**Qume** Milpitas, Calif.	3.7	8.3	12.8	222.3	21.3	8.7	72.2	2/90
100	98	**AST Research** Irvine, Calif.	3.5	18.4	8.8	533.8	16.9	35.1	NM	6/90

NM = not meaningful

Viewing the terminal market through X windows

X-terminal sales seem set for steady growth. But early entrants into the market feel the heat from computer companies and Asian clones

By Rick Whiting

A battle royale is shaping up in yet another booming computer market. Sales of X terminals, sophisticated desktop displays positioned above so-called dumb terminals and below more costly PCs and workstations, are expected to double to $324 million this year. Unfortunately, the vendors who pioneered the product are threatened by the turmoil within the fast-growing but maturing market.

Major computer vendors such as IBM, Digital Equipment Corp., and Hewlett-Packard Co. have made major inroads into the market, and Asian clone makers are about to invade in force. Worse, X-terminal makers are being squeezed by the PC and workstation price wars. The volatile nature of the X-terminal market leads Stephen J. King, marketing director for Tektronix Inc.'s Network Displays Division, to paraphrase a famous Andy Warhol quote to describe the turmoil: "Every vendor has had its 15 minutes of glory."

Much of the market mayhem is due to the functionality and positioning of X terminals, which are caught in the heated price and performance competition among personal computers, workstations, and computer terminals. "We view [X terminals] as part of the battle for the desktop," explains industry analyst Patty Chang of Dataquest, Inc., San Jose. X terminals are designed to take advantage of the X Window System, a windowing standard developed by the Massachusetts Institute of Technology in the mid-1980s. X windows allows users to access multiple applications running on minicomputers, servers, or workstations in a network.

The first X terminals hit the street in 1988 and 1989 from pioneers Network Computing Devices Inc. (NCD) in Mountain View, Calif., Visual Technology Inc. of Westborough, Mass., Human Designed Systems Inc. of King of Prussia, Pa., and Tektronix's Network Displays Division of Wilsonville, Ore. Distributors, OEMs, and end users were delighted at the rock-bottom prices for PC- or workstation-like functionality, and sales took off.

Eileen O'Brien, director of Framingham, Mass.-based International Data Corp.'s terminal service, says that X-terminal vendors shipped 64,000 units last year at a total value of $161 million, up from 13,000 units valued at $41 million in 1989. She expects 1991 shipments to hit 136,000 units valued at $324 million. Dataquest's Chang says X terminals currently sell for as low as $1,000, and the average price is about $2,500. Though high-end X-terminal units cost more, they are more than competitive with diskless workstations at $4,000.

Providing a boost for the market is the growing number of color X terminals now being shipped by most vendors. Because color allows users to take better advantage of X-terminal capabilities, such as the three-dimensional effect of the Motif graphical user interface, the avail-

Liane Enkelis

NCD's co-founder Judy Estrin says that, while the X terminal market is still embrionic, the devices are viable contenders with PCs and workstations for the desktop

ability of color X terminals is spurring sales. "We're seeing color terminals have much more of an influence than people had anticipated," says Tom Arthur, IBM's X station product development manager. IDC's O'Brien expects that 43% of all X terminals shipped this year will be color.

Attractive prices are also expected to encourage robust market growth. O'Brien predicts annual revenue growth of 30% to 40% for the market, while Dataquest's Chang forecasts more than 50% compounded average annual growth between 1991 and 1995, to $1 billion by middecade. "This is one of our fastest-growing markets right now," says Dave Morse, marketing manager at HP's Panacom Automation Division in Waterloo, Ont. "We view it as a tremendous opportunity."

While most marketing managers would be thrilled at 30% to 50% growth rates, current forecasts are a sharp comedown from earlier predictions. Several years ago Gartner Group Inc., a Stamford, Conn., market research firm, foresaw annual sales of X terminals reaching 200,000 units in 1990 and a half a million units this year. The shortfall from Gartner's earlier prediction reflects the maturing market faced by X-terminal makers. Indeed, Forrester Research Inc., Cambridge, Mass., last year estimated that X terminals would remain a niche market, peaking at only 200,000 units per year by 1994.

Dataquest estimates that worldwide, 74% of all installed desktop systems are personal computers, with text terminals accounting for another 22.8%, workstations 1.4%, and X terminals a minuscule 0.4%, followed by proprietary graphics terminals and other specialized displays.

Marketers of X terminals, in fact, often find themselves competing with workstation suppliers as much as with each other. Since Sun Microsystems Inc. in Mountain View, Calif., is the leader at the low end of the workstation price spectrum, the company is often the target of X-terminal makers. "No doubt about it, our biggest competitor is Sun," says NCD co-founder and executive vice president Judy Estrin.

Educating potential buyers is the biggest challenge for X-terminal makers. Beyond acquisition costs, for example, vendors pitch X terminals as cheaper than workstations to install and maintain, with lower training costs. And because they run off of central computers, X terminals offer better security and easier administration. Sun executives counter by saying that workstations provide more value for the dollar.

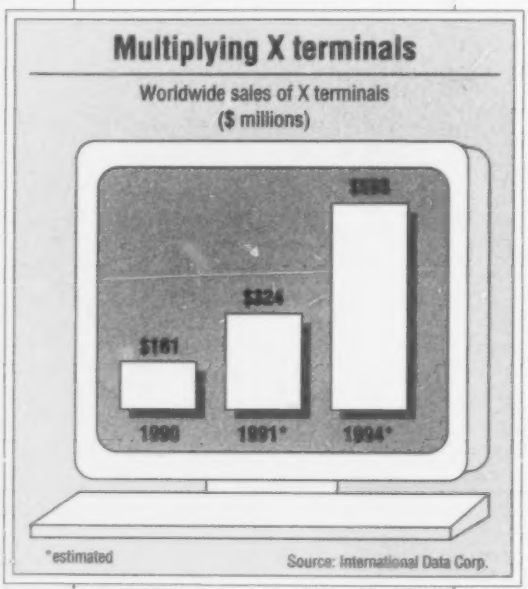
As for the major computer vendors like IBM and DEC, they tout X terminals as complementary to their other desktop devices. IDC's O'Brien explains that a broad product line provides a marketing advantage to those computer companies—some buyers want workstations *and* X terminals. Because many workstations offer more power than one user may ever need, some customers attach one or more X terminals to each workstation, turning it into a multi-user computer to reduce the per-user cost. IBM's Arthur says that most of his company's X terminals are sold as add-ons for its RS/6000 workstations.

Looking to the future, market optimists look for huge growth from user sites now dominated by dumb terminals used for graphics and even text applications. Dataquest estimates that in 1990 alone, some 6 million dumb terminals were sold worldwide, generating factory revenue of $4.5 billion. But so far, much of that lucre has eluded X-terminal vendors.

Prices, service, and a lack of appropriate software are the key obstacles to an explosion of X-terminal demand. A decline in X-terminal prices, to $750 or lower, is needed to convince dumb terminal buyers to switch. Furthermore, X terminals are not "plug-and-play"—they require more service and user training than standard terminals. And because the X Window System is predominantly used in scientific and engineering circles, there is a dearth of X window software for commercial applications.

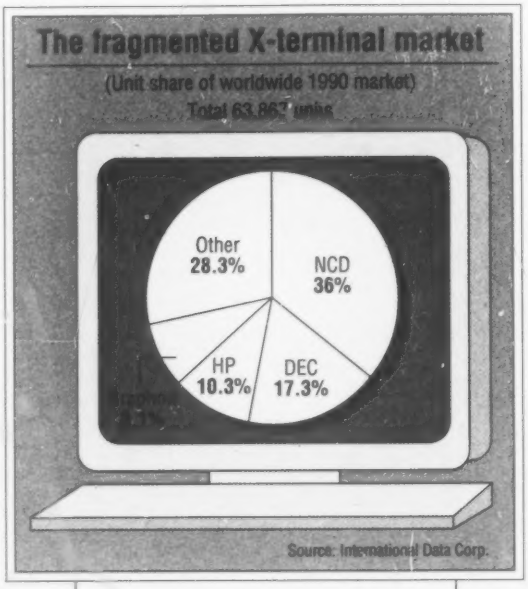
Dataquest's Chang contends that real demand from commercial accounts is up to two years away, while IDC's O'Brien says that 1994 to 1995 is more realistic. "The commercial market is just starting to take off" for X terminals, notes David Laws, president of NCR's Applied Digital Data Systems subsidiary in Hauppauge, N.Y.

IN ADDITION TO the development of commercial software, broad-based distribution will be critical to the success or failure of the vendors. The majority of X-terminal sales are currently made directly to users—Tektronix recently sold 1,500 units to U.S. West Inc., for example. While the major com-



puter companies will rely on their direct sales forces, smaller companies must line up other channels of distribution to take advantage of increased interest in X terminals.

NCD appears to have the advantage here because it has already assembled a solid stable of OEMs (original equipment manufacturers), including Motorola, Pyramid Technology, Mips Computer Systems, Data General, Solbourne Computer, Convex Computer, Bull HN, and others. Visual Technology has inked OEM deals with Kubota Computer of Japan and Stardent Computer, and the company is jointly developing a new X terminal with Intergraph, according to Visual Technology's Michael Braca, vice president of advanced marketing and technology.



A FEW COMPANIES have even taken the first steps toward volume shipments of X terminals through industrial distributors. Hewlett-Packard lined up Lex Electronics Inc. and Hall-Mark Electronics Corp. to carry its X terminals, says HP's Morse. But ADDS's Laws fears that X-terminal demand will have to grow for another 18 months to two years before industrial distributors become a viable channel.

While some observers say that a shakeout among X-terminal vendors is imminent, a more likely scenario is a continuation of the trench warfare that has characterized the market. Although Visual Technology and Human Designed Systems were among the first to enter the X-terminal market, they and other smaller vendors were shoved aside by IBM, DEC, Hewlett-Packard, and ADDS (see table).

Among the early entrants, only NCD has stayed ahead of the big computer makers. NCD remains the market leader, followed by DEC's Video, Image, and Printer Systems Business Group of Maynard, Mass., and Hewlett-Packard. Although Tektronix's market share remains relatively low—5.8% according to IDC—most observers expect the company to leverage its market position and expertise in graphics terminals and gain ground in the X-terminal market.

But all of these companies now face stiffer competition from Asian companies that have begun marketing X terminals recently. At the Xhibition trade show in San Jose in June, Asian companies unveiling new X terminals included Japan's Marubeni, Arche Technologies of Taiwan, and Samsung Electronics of Korea. They hope to duplicate the success Asian companies have had in the monitor, terminal, and clone personal computer markets by following the same strategy: Use the modest wage scales of offshore plants and volume manufacturing to produce low-cost products and quickly gain market share.

X terminals are caught in a heated price and performance competition with PCs and workstations

One industry observer points to a Taiwan government-industry consortium, now working to develop low-cost X terminals, as proof of the seriousness with which Asian companies are attacking the market. "They're going to be a threat, no doubt about it, particularly at the low end," says Tek's King.

But analysts and U.S. vendors say that the X-terminal market may not be as easy to penetrate with clones as was the case with personal computers. PCs are built around a single microprocessor architecture and operating system and so are easy to clone. "It may not be a challenge to build an X terminal," says Greg Blatnik, marketing vice president of the X-terminal division of Micronics Computers Inc., Fremont, Calif. "It is a challenge to build a good one."

What's more, service and support requirements for PCs are relatively simple. X terminals, on the other hand, are more sophisticated products that often operate in multivendor networks and so require more expertise to sell, service, and support. Asian manufacturers also lack the distribution channels required to successfully sell X terminals.

Despite the heated competition of the X-terminal market, vendors are buoyed by sales predictions: Dataquest estimates more than 860,000 units valued at over $1 billion in factory revenue worldwide in 1995, a sizable piece of the desktop market considering that 600,000 PCs and 2.2 million workstations will be sold that year for X Window applications.

"It is still an embryonic market," concludes NCD's Estrin. "But there is no longer any controversy over whether X terminals are a viable alternative." □